

Title: **Rural Roads Vulnerability Reduction Assessment, Mitigation Measures, and Training**

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Hazards Examined: Multi-hazard

Study emphasis: Economic Development, Disaster Preparedness, Disaster Response and/or Disaster Reconstruction Application

Summary: This study involves an assessment, through community involvement, surveys and subsequent reviews of given rural road conditions, and the development of roads ‘worklists’ that are aimed at defining needed improvements and “disaster proofing” roads and roadway systems. Outputs have included identification of specific needed road work with use of the worklist and drawings, and conducting training on basic design, construction, and repair measures applicable to minimizing vulnerability of the roads and reducing environmental damage. (See attached summary write-up)

Vulnerability Indicators: -Roads located in vulnerable areas (on landslides, in floodplains, on steep slopes, etc).
-Frequent need for road maintenance.
-Damage or needed repairs from small storm events.
-Undersized drainage structures.
-Critical transportation links between communities or areas.

Data Requirements: -Road inventories.
-Hazard risk maps, if available.
-Qualitative field assessment of road conditions.

Output: -An inventory of needed road work, by priority.
-Work lists developed for needed work (See Attached Work List forms)

-Documentation of measures and conducting training on measures useful to reduce road damage from disasters.

Results of Application at Case Study Site:

- Implementing road improvements to make roads more “storm resistant”.
- Less frequent and less severe damage to roads (less plugged pipes and washouts, etc), less costly repairs, and less road closures.

Lessons Learned:

See attached list of measures for reducing vulnerability of rural roads to natural disasters.

**URL(s) or bibliographical references to/for publications about your case study:
Key references on this specific issue:**

PIARC World Roads Association. 1999. Natural Disaster Reduction for Roads, Final Report 72.02B, Paris, FR. 275p.

Copeland, R.; Johansen, K. 1998. Water Roads Interaction: Examples from Three Flood Assessment Sites in Western Oregon. Report 9877-1805-SDTDC, San Dimas, CA. Technology and Development Center, U.S. Department of Agriculture, Forest Service. 15p.

De La Fuente, J. 1998. The Flood of 1997, Klamath National Forest. Unpublished Report, Yreka, CA. U.S. Department of Agriculture, Forest Service.

Rural Road Vulnerability Reduction Assessment, Mitigation Measures, and Training

By

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Summary

The US Forest Service has gained considerable experience in storm damage assessment and repair work over the past 30 years. Major storm damage repair programs have been undertaken in the western United States after the storm events of 1972, 1986, 1995, and 1997. Also considerable experience has been gained with road work throughout Central America after Hurricane Mitch and in the Caribbean after Hurricane Georges.

ASSESSMENT

Two levels of assessment have been used for road storm damage projects, depending on the scope of needed work and geographic extent of damage.

1. Program Prioritization of Roads (Large Area Assessment)
2. Project Road Work and Identified Mitigation Measures (Specific Existing Roads)

Program Priorities

Program Priorities are influenced by both Social and Physical considerations. Project selection has been based upon a subjective consideration of all priorities and factors, and the need to develop a balanced program of work.

Remember--Long-term Programs Need Short-term Successes!

Social Considerations

- Community Needs and Desires
- Community Involvement and Sustainability
- NGO support

Physical Considerations

- Watershed Priorities
- Road Use and Importance
- Feasibility of Desired Repairs
- Cost-Effectiveness

Project Work Priorities

Project Work Priorities have typically been based upon road use and standard of the road. The most heavily used arterial and collector roads usually receive top priority and are repaired first and best. Secondary, local roads typically receive a lower priority. Road managers must have an inventory of or know their transportation system!

MITIGATION MEASURES

For any specific existing road or road system, a variety of planning and design tools are available to rural roads managers and engineers to help “storm-proof” a road and reduce the vulnerability of roads to natural disasters. A list of specific recommendations, or “Best Practices”, is presented on the following pages (attached).

The work needed can be identified in the field on a work list, where the specific item, site conditions, and description of work, are listed by station or milepost along the road. See the attached Work List form and an example of a specific work list developed for a road project in Honduras after Hurricane Mitch. Most identified items of work involve improving roadway surface drainage to avoid water concentration and having well designed drainage crossings. Other common items of work include subgrade stabilization, slope treatments or needed retaining structures, and erosion control measures.

TRAINING

Over the past eight years considerable training has been conducted throughout Latin America on “Minimum Impact Rural Roads” and on the application of “Best Management Practices” to low-volume roads. The objectives of this training have been:

1. To improve basic road planning, design and construction, and repair techniques;
2. To discuss Environmental Analysis and reduce adverse environmental impacts from roads; and
3. To reduce the vulnerability of roads to natural disasters, particularly from storm events and flooding.

Work List Form

Road/Area

[illegible]

Work List (Sample)

Road/Area--Desvio Sabana Hoyosa (Road P1T4)

Location, Station or MP	Road Width m	Road Grade %	Cross- Slope %	Code	Work Description
D1 (MP 0.0)					Intersection with P1 at Saddle
	4+1RL	0-18			Inslope Road to Ditch, Clean Ditch
D2					Install 24" Pipe & Drop Inlet, Drain Left
		11-12			Outslope Road, Reshape Rough Road Surface
D3 (MP 0.1)					Construct Dip, Drain Left
		3			Outslope Road
D4					Clean Existing Timber Culvert
		3			Inslope Road to Ditch
D5					Excavate Inlet Basin for Timber Culvert
	3.5+1RL	+3--3			Inslope Road and Reshape Ditch
D6					Replace Damaged Timber Culvert with an Armored Dip
		+3--3			Reshape Road and Ditch
D7					Construct Dip, Drain Left
		3 -5			Inslope Road, Reshape Ditch
D8 (MP 0.35)					Existing Timber Bridge Marginal—Eventually Replace with an Armored Ford
		7			Inslope Road, Reshape Ditch
D9					Replace Plugged Existing Timber Culvert With Culvert or Dip (Lower Grade 45 cm)
		2-10			Outslope Road and Construct 3 Dips, Drain Left
D10					Construct Dip, Drain Right
		10-16			Smooth Existing Roadway Alternative-Relocate Road between D10 & D11
D11					Construct Dip Left
		6			Outslope Road
D12 (MP 0.7)					At Gentle Saddle—Road OK
		2-5			Outslope Road, Construct 6 Dips between D12 & D13
D13 (MP 1.1)					Begin Ridgetop Road, Road OK

Measures for Reducing Vulnerability of Rural Roads to Natural Disasters

- Identify areas of historic or potential vulnerability, such as geologically unstable materials or areas, areas subject to flooding, or areas of high volcanic or seismic hazards.
- Avoid problematic areas and avoid road locations in areas of high natural hazard risk, such as landslides, rock-fall areas, steep slopes (over 60-70%), wet areas, saturated soils, etc.
- Avoid or minimize construction in narrow canyon bottoms or on flood plains of rivers that will inevitably be inundated during major storm events.
- Provide good roadway surface drainage and rolling road grades so that water is dispersed off the road frequently and water concentration is minimized.
- Minimize changes to natural drainage patterns and crossings to drainages. Drainage crossings are expensive and potentially problematic, so they must be well designed. Changes to natural drainage patterns or channels often result in either environmental damage or failures.
- Out slope roads whenever practical and use dip cross-drains for surface drainage rather than a system of ditches and culverts which require more maintenance and can easily plug during major storm events.
- Use simple fords or vented low-water crossings (vented fords) for small or low-flow stream crossings instead of culvert pipes that are more susceptible to plugging and failure. With fords, protect the entire wetted perimeter of the structure, protect the downstream edge of the structure against scour, and provide for fish passage where needed.

- Perform scheduled maintenance to be prepared for storms. Insure that culverts have their maximum capacity, that ditches are cleaned, and that channels are free of debris and brush than can plug structures. Keep the roadway surface shaped to disperse water rapidly and avoid areas of water concentration.
- Typically keep cut and fill slopes as flat as possible and well covered (stabilized) with vegetation to minimize slumping as well as minimize surface erosion. Well-cemented but highly erosive soils may best resist surface erosion with near-vertical slopes that minimize the surface area exposed to erosion.
- Use deep-rooted vegetation for biotechnical stabilization on slopes. Use a mixture of good ground cover plus deep-rooted vegetative species, preferably native species, to minimize deep-seated mass instability as well as offer surface erosion control protection.
- Locate bridges and other hydraulic structures on narrow sections of rivers and in areas of bedrock where possible. Avoid fine, deep alluvial deposits (of fine sand and silt) that are scour susceptible and problematic, or which otherwise require costly foundations.
- Design critical bridges and culverts with armored overflow areas near the structure to withstand overtopping, or have a controlled “failure” point that is easy to repair. Alternatively over-sizing the structure and allow for extra freeboard on bridges to maximize capacity and minimize risk of plugging. Also avoid constricting the natural channel.
- Insure that structural designs for bridges, retaining walls, and other structures include appropriate seismic design criteria and have good foundations to prevent failures during earthquakes.
- Place retaining structures, foundations, and slope stabilization measures into bedrock or firm, in-place material with good bearing capacity to minimize undermining, rather than placing these structures on shallow colluvial soil or on loose fill material.